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Peach Disease Control

By

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Peach Disease Control

With the development of the commercial peach industry in Georgia came the usual specific parasites which follow the concentration of a crop in any section. There has existed since the advent of these pests a constant struggle between insects and fungi on one side, and the host trees aided by the cultural methods of men on the other. With the development of protective sprays some of the parasites as San Jose scale, *Aspidiotus perniciosus (Comst.)*, and peach scab, *Cladosporium carpophilum (Thuem.)*, ceased to be a menace to peach trees and fruit which are properly sprayed. Other pests, as curculio, *Conotrachelus nenuphar (Herbst.)*, and the brown rot fungus, *Sclerotinia cinerea (Bon.)*, have yielded less readily to sprays; their control being more dependent upon cultural methods.

The advent of self-boiled lime sulphur developed by Scott and Ayers (1) gave great promise for the control of brown rot (Figure 1.), because it appeared to hold the fungus in check without the injury to the leaves and fruit which resulted from the application of Bordeaux mixture used previous to 1908. For several years peach growers felt confident that the new combination sprays, using self-boiled lime sulphur as a control for peach scab and brown rot, and arsenate of lead for curculio, would control these pests. Several seasons of successful production strengthened the opinion that clean cultural methods were unneccessary. This proved to be a serious mistake as shown by the cumulation of curculio and brown rot which resulted in the severe outbreak of 1920 when weather conditions favored the parasites and lessened the effectiveness of the sprays. The losses of 1920 caused many growers to lose faith in sprays as a means of curculio and brown rot control. After the harvest of 1920 some of the growers returned to the custom of cleaning up their orchards. Others believed that sprays would control these pests in a normal year and that there would not be a recurrence of the wet season of 1920; therefore they did not go to the expense of cleaning up their orchards immediately following the harvest. These uncleaned orchards served as breeding places and centers of infection for adjoining sections, and even with more favorable weather conditions, the season of 1921 was not a successful one for many commercial growers.

A survey of the main peach raising sections of Georgia, in co-operation with the United States Bureau of Markets in 1920, showed that 40 to 60 per cent of the fruits, as packed to ship, were wormy and an average of 10 per cent showed brown rot. Ninety per cent of this brown rot followed curculio injury.

Various combinations of sprays and dusts were used by different growers in 1920, but the data failed to disclose any successful spray or dust combination for the control of curculio and brown rot. As an illustration two plats of 300 trees each in a commercial orchard were treated by the grower as follows:

FIGURE 1

After Quaintance. Georgia Exp. Sta. Bul. 50, 1900. Brown Rot of peaches, showing fruits in advanced stages of decay bearing tufts of conidia on their surfaces.

Plat 1, was thoroughly sprayed four times with Atomic sulphur and arsenate of lead, made up at the rate of 20 pounds of Atomic sulphur, 20 pounds of lime, and three pounds of powdered arsenate of lead, to 200 gallons of water. Counts made at harvest time showed 59 per cent wormy—(curculio), 15 per cent wormy and rotting—(brown rot), one per cent rotting, no scab, and 25 per cent sound fruit.

Plat 2 was dusted four times with a mixture of 80 per cent sulphur, five per cent arsenate of lead, and 15 per cent hydrated lime, used at the rate of 100 pounds to 500 trees. At harvest time this plat showed 68 per cent wormy, six per cent wormy and rotting, one per cent rotting, no scab, and 25 per cent sound fruit.

As there were no unsprayed trees from which to make counts for comparison with the above it was difficult to estimate the value of the spray and dust in this case, but it was evident that from the standpoint of the commercial grower 25 per cent of sound fruit was not a profitable crop.

The opinion was prevalent among growers in 1920 that to some extent the failure to control curculio was due to the poor quality of the arsenate of lead obtainable. One grower illustrated this point by citing a case in his orchard where a colored laborer by mistake, used 24 pounds of powdered arsenate of lead in place of 20 pounds of lime, and four pounds of arsenate of lead, mixed with 20 pounds of Atomic sulphur and 200 gallons of water. Four rows of seven year old Elberta trees were sprayed with this mixture. On examination of the trees a few weeks later the writer observed no more spray burn or defoliation of these trees than of adjoining Elberta trees of the same age sprayed with the standard 20-4-20-200 Atomic sulphur.

The data obtained from the few orchards where fruit above the average in market quality was raised in 1920 indicated that the treatments given were similar in material used and no more thorough than in other orchards. Such orchards, however, had an advantage in being isolated from three to eight miles from other commercial orchards. In 1920 and again in 1921 it was observed that this matter of isolation was of great value in the control of curculio and brown rot. In these isolated orchards the fruit had from 10 to 20 per cent of worms, and less than one per cent of brown rot.

In order to obtain fruit of better quality for continuing test-shipments of peaches, the Federal Bureau of Markets requested the Georgia Experiment Station to supervise the spraying of two blocks of trees from which it was intended to make car lot test-shipments in 1921. The orchard where this work was conducted was on a farm near Marshallville, Georgia, which had been raising peaches on a commercial scale for the past 40 years.

The wormy and rotten fruits were not removed from this orchard following the harvesting of the 1920 crop, but after the leaves had fallen the trees were pruned and the mummied fruits were picked off, to destroy centers of brown rot infection. During the last week in January the trees were given a thorough application of concentrated lime-sulphur used at the rate of one gallon of concentrated solution to seven gallons of water.

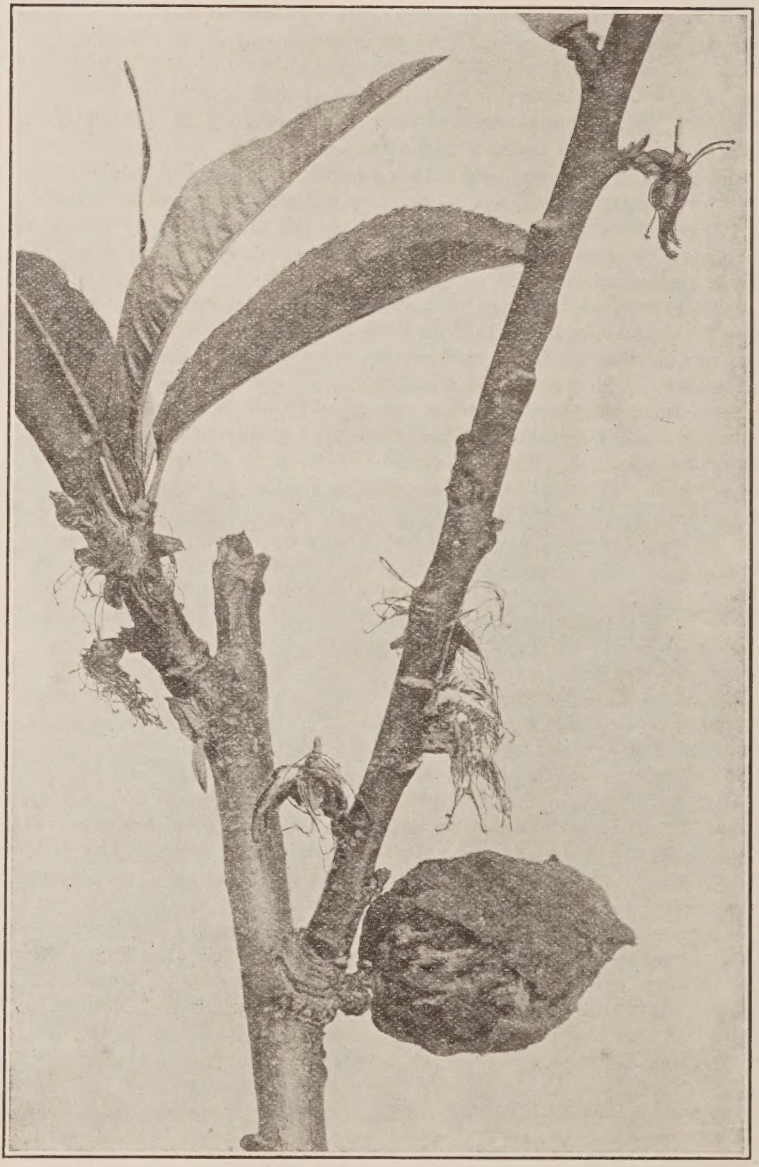

FIGURE 2

A fruit which rotted in 1920, and remained attached to the tree as a mummy thruout the winter. The blossoms which developed near this mummy in the spring of 1921 were blighted.

The soil throughout the orchard was turned with plows, and during the winter all trash which might harbor curculio was destroyed by cultivating and hoeing. All roads, ditch-banks, and fence rows were freed from dead weeds and wild plum thickets by plowing, hoeing, and burning, so that by spring the soil in and about the orchard was clean.

The two blocks of test trees were divided into five plats each, to obtain data as to the value of the different sprays and dusts. The plats were made of sufficient size to obtain at least a car lot from each if desired.

The block of 10 year old trees of the Georgia Belle variety consisting of 25 rows of 60 to 70 trees to the row running north and south was divided into five plats of five rows each, to be treated as follows:

Plat 1, to be sprayed with Atomic sulphur and arsenate of lead at the rate of 20 pounds of Atomic sulphur, four pounds of powdered arsenate of lead, and 20 pounds of lime to 200 gallons of water.

Plat 2, to be dusted with 80-10-10 dust, i.e., a mixture containing 80 per cent sulphur, 10 per cent arsenate of lead, and 10 per cent lime.

Plat 3, to be given no summer spray, and thus to serve as a check.

Plat 4, to be sprayed with self-boiled lime sulphur and arsenate of lead made up at the rate of 32 pounds of stone lime, 32 pounds of sulphur, and four pounds of powdered arsenate of lead to 200 gallons of water.

Plat 5, to be sprayed twice with Atomic sulphur and arsenate of lead, made up as for plat 1, and dusted twice with the same dust used in plat 2.

The block of 10 year old Elberta trees consisting of 25 rows of 62 trees to the row, running east and west, was divided into five plats of five rows each, to be treated in like manner as the Georgia Belle plats.

On March 10, 1921 a number of commercial orchards were visited to see how they compared with the test blocks in regard to clean culture. In one orchard of Elbertas numerous mummied peaches were observed on the trees; individual trees having as many as 16 mummies attached to the twigs, (Figure 2). A number of these mummied fruits were collected and brought to the Experiment Station where some of them were placed in moist chambers under favorable conditions for the development of the causal fungus. By March thirteenth, numerous conidia, or summer spores, had developed on the mummied fruits in the moist chambers, indicating that under favorable conditions such as warm, moist weather the mummies left on the trees are important sources of infection due to the formation of large numbers of conidia. A water suspension of these conidia was sprayed onto some of the leaves and blossoms of Early Rose peach trees at the Station on March thirteenth. The twigs thus inoculated were enclosed in paper bags. A week later the bags were removed and it was observed that many of the blossoms had shriveled and turned brown. Some of these blossoms were placed in a moist chamber and within two days tufts of conidia developed on the calyces. On examination these were seen to be spores of *Sclerotinia cinerea.* This indicated that the over-wintered mummied fruits from the trees were able to produce conida capable of causing brown rot of the blossoms, known as blossom blight.

Mummied fruits which dropped to the ground and had been more or less covered with trash and soil were examined in numbers at various times

FIGURE 3

Showing the fruit from a normal peach blossom in the center in contrast to blighted blossoms of several early varieties.

during the winter and spring, but in only two cases were specimens found which bore apothecia. Examination showed that these contained well developed ascospores capable of causing infection. The small number of mummies which produced apothecia and ascospores would indicate that the perfect stage of *Sclerotinia cinerea* is not of as much importance in spreading brown rot as is the imperfect or conidial stage, under Georgia conditions.

On March fourteenth and fifteenth, 1921 there was sufficient rain in the Fort Valley section to stop spraying operations, and by March seventeenth the occurance of blighted blossoms was reported from several orchards of the Red Bird and Mayflower varieties. This indicated that the warm rainy weather of the fourteenth and fifteenth, while early varieties were in blossom, favored the production of conidia which infected the blossoms and caused them to blight and die instead of setting fruit, (Figure 3).

From March seventeenth to twenty-third, blossom blight was observed in commercial orchards in several sections of Georgia. In some cases the blighted blossoms had tufts of conidia on the calyces, indicating that the blighting was due to the brown rot funges. In other cases the blighted blossoms bore no spores when collected, but on being placed in moist chambers for a few days such blossoms developed conidia of *Sclerotinia cinerea,* showing that the blighting was due to this fungus.

Percentage counts made in several orchards and on different varieties, showed that 25 to 90 per cent of the blossoms were blighted, thus in some varieties resulting in the loss of almost the entire crop, (Figure 4).

Field observations indicated that blossom blight in Georgia was serious only on early varieties, including Mayflower, Red Bird, Early Rose, Alexander, Victor, and Early Carmen. Little or no blossom blight was observed on Carmen, Hiley, Georgia Belle, Elberta, or Hale. In cases where a block of an early variety as Mayflower adjoined a block of a later variety such as Carmen, one could tell to the row where one left off and the other began, by the presence of many well developed fruits on the Carmen trees in contrast to very few fruits, and many blighted blossoms on the Mayflower trees.

In the spring of 1921 it was observed that the later maturing varieties such as Carmen, Hiley, Georgia Belle, Elberta and Hale, were in blossom from March fifth to tenth; while the Mayflower, Red Bird, Early Rose, Victor, etc., as usual, blossomed somewhat later, being in bloom this year from March twelfth to seventeenth. In 1921 these dates of blossoming had an important bearing on the fruit set by the different varieties. The later maturing varieties had finished blooming and set their fruit prior to March fourteenth and fifteenth when rainy weather rendered favorable conditions for the brown rot fungus to produce conidia in large numbers. The early varieties in blossom from the twelfth to the seventeenth were infected by these conidia and resulted in a large percentage of blossom blight. Since the early varieties always blossom several days later than the late maturing varieties they are more liable to blossom blight because of additional time for the fungus to develop conidia, with which to infect the blossoms.

FIGURE 4

A twig of the Mayflower variety showing the large percentage of blossoms which were blighted.

Some commercial growers have ceased to raise early varieties because they have learned from experience that these varieties develop a large percentage of brown rot both in the orchard and in transit. The fact that the early varieties are more liable to brown rot infection at blossoming time is one reason why they are not profitable commercially. This blossom infection causes these early varieties to be centers from which the brown rot fungus makes its extensive new infections. From these the fungus spreads to the early fruits as they mature, and thence to the later varieties throughout the season.

Some growers on casual observation concluded that blighted blossoms were due to frost injury and therefore would drop to the ground without more serious results than a reduction in the amount of fruit set. This was an incorrect conclusion as has been pointed out by Quaintance[2], Jehle[3], and others, who have observed that blighted blossoms cling to the trees and continue to produce conidia capable of infecting fruits as they approach maturity throughout the season. Observations during the season of 1921, substantiate the above to the effect that as the growth of the brown rot fungus progresses from the blossoms into the twigs, gum is exuded by the twigs in many cases and this tends to seal the blighted blossoms to the twigs where they remain throughout the season. With the recurrence of rainy weather it was observed that fresh tufts of conidia were produced on the blighted blossoms. This year blighted blossoms were observed on the trees eight months after they were blighted.

As pointed out by Chester[4], Cordley[5], Quaintance[2], Scott and Ayres[1], Jehle[3], and Cook[6], the brown rot fungus grows down into the twigs forming cankers of various sizes, some of which kill twigs by girdling. Later in the season similar cankers are produced by the fungus growing into twigs from rotting fruits. In these cankers the brown rot fungus may live over winter and produce spores to infect the blossoms the next spring; therefore it is important that cankers be removed from the trees by pruning. These cankers may be readily detected while the blighted leaves resulting from the cankers are still attached to the twigs (Figure 5). Growers are therefore advised to go over their trees and prune out cankers just after the harvest season so that the cankered twigs may be removed from the orchard along with the rotten fruit collected from the trees and the ground.

The spray schedules used for peaches in Georgia provide for the first application just as the calyces or shucks begin to split on the newly set fruits. Howard and Horne[7] report that an application of concentrated lime-sulphur, 1-9, or 4-5-50 Bordeaux mixture will control brown rot of blossoms of apricots, in California, if applied shortly before the trees come into bloom. In the spring of 1921 an orchard of the Red Bird variety was given a delayed dormant spray of 1-8 concentrated lime-sulphur just as the buds were swelling. A large percentage of blighted blossoms were found in this orchard on March seventeenth, thus indicating that this spray had been of little value in the control of brown rot of Red Bird blossoms under Georgia conditions.

Under conditions existing in New York state Jehle[3] reports that concentrated lime-sulphur (1-40) applied just before the blossoms opened

FIGURE 5

Cankers caused by the Brown Rot fungus growing from the blighted blossoms into the twig. The killing of the young shoots as indicated by the withered leaves lessens the growth of new fruiting wood.

resulted in no injury to the blossoms or leaves and controlled the brown rot fungus so that very little blossom blight occurred. Similar trees sprayed at the same time with 8-8-50 self-boiled lime-sulphur developed just as much blossom blight as unsprayed trees.

BROWN ROT AND FROST INJURY OF GREEN FRUITS

Following frosts on April eleventh and twelfth green fruits three to four inches in circumference, of the Mayflower variety, were found in various stages of decay. About the same time green fruits of the Red Bird, Hiley and Georgia Belle varieties in various stages of decay were received from the Field Laboratory of the Federal Bureau of Entomology at Fort Valley. Fruits similar in size, but shriveled and dark colored at the pit, were received from a representative of the State Board of Entomology at Macon. There was no infection associated with the shriveled, discolored fruits from Macon, so this trouble was diagnosed as frost injury. The decaying green fruits showed no shriveling or discoloration at the pit, but sclerotial like bodies had formed on the surface of some of the fruits. On being placed in moist chambers for a few days conidia of *Sclerotinia cinerea* developed on the surface of the fruits. Pure cultures of *Sclerotinia cinerea* were obtained from platings of decayed tissues from the interior of the fruits.

FIRST APPLICATION OF SPRAY AND DUST TO TEST PLATS

On March 24th and 25th, 1921, when the first applications were made the fruits on both Georgia Belle and Elberta varieties were one-third to one half covered by the calyces or shucks, so that the portion of the fruit toward the stem end received no spray.

The plats were sprayed or dusted according to the plan outlined, using a Niagara power duster and two Bean 200 gallon power sprayers. These maintained a pressure of 125 to 175 pounds while spraying was in progress.

On plats 1 and 5, a solution of Atomic sulphur and arsenate of lead was used at the rate of .75 gallon per tree requiring about 13 seconds per tree for application.

On plat, 2, 80-10-10 dust was used at the rate of 0.3 pound per tree requiring 4.5 seconds per tree for application.

On plat 3, no spray or dust was applied.

On plat 4, a solution of self-boiled lime-sulphur and arsenate of lead was used at the rate of 0.8 gallon per tree, requiring about 13 seconds per tree for application.

Similar amounts of material and time were employed in the first application to the test plats of Elberta trees.

SECOND APPLICATION

The second application was given to the two test blocks April seventh and eighth, 1921.

On plats 1 and 5 of each block a solution of Atomic sulphur and arsenate of lead was used at the rate of 1.25 gallons per tree, requiring about 13 seconds per tree for application.

On plat 2 of each block, 80-10-10 dust was used at the rate of 0.26 pound per tree, requiring 6.5 seconds per tree for application.

On plat 3 no spray or dust was used.

On plat 4 of each block a solution of self-boiled lime-sulphur and arsenate of lead was used at the rate of 1.25 gallons per tree, requiring about 13 seconds per tree for application.

It will be noted that with the exception of plat 2 of each block, more solution was used per tree in the second application, because of the increased size of the fruit and leaves. Nozzles with slightly larger holes in the discs increased the volume of application so that the total time required per tree averaged about the same as in the first application.

THIRD APPLICATION

The third application was given to the two test blocks May 25th and 26th, 1921.

On plat 1 of each block a solution of Atomic sulphur and arsenate of lead was used at the rate of 1.25 gallons per tree requiring about 13 seconds per tree for application.

On plat 2 of each block 80-10-10 dust was used at the rate of 0.36 pound per tree requiring six seconds per tree for application.

On plat 3 of each block no spray or dust was applied.

On plat 4 of each block a solution of self-boiled lime-sulphur and arsenate of lead was used at the rate of 1.25 gallons per tree, requiring about 13 seconds per tree for application.

On plat 5 of each block 80-10-10 dust was used at the rate of 0.25 of a pound per tree requiring about six seconds per tree for application.

At the time the third application was made no brown rot was seen, and only a few wormy fruits were observed in the test plats.

FOURTH APPLICATION

The fourth application was given the Elberta block June eighteenth, 1921.

As it was estimated that the Georgia Belles would ripen within a month after the time the third application was made it was decided to omit the fourth application to this variety.

The amount of arsenate of lead was reduced from four pounds to three pounds per 200 gallons of solution for the fourth application, because some burning of the foliage had developed as a result of the third application.

Plat 1 was sprayed with Atomic sulphur and arsenate of lead at the rate of 0.62 gallon per tree, requiring about eight seconds per tree for application.

Plat 2 was dusted with 80-10-10 dust using 0.3 pound per tree, requiring five seconds per tree for application.

Plat 3 was given no spray or dust.

Plat 4, was sprayed with self-boiled lime-sulphur and arsenate of lead 0.62 gallon per tree, requiring about ten seconds per tree for application.

Plat 5 was dusted with 80-10-10 dust, using 0.27 pound per tree, requiring six seconds per tree for application.

Up to the time the fourth application was made the season had been dry as compared with that of 1920, yet a few cases of brown rot had developed since the third application, especially on the check plats.

YIELD RECORDS

Due to a series of unfortunate circumstances it was found impractical to obtain data on the fruit in transit, therefore the following field data are the only bases on which to judge the relative value of the sprays and dust used in these 1921 tests.

It was observed that during the various applications the wind carried the sprays and dust to trees in other plats than the one intended, therefore to exclude as far as possible errors due to this, the field notes were taken on the center row of each five-row plat. In such rows designated as count rows 10 trees were selected at intervals of four to five trees, beginning with the fifth or sixth tree from the end of the row. The count row in each plat was labeled and each count tree was marked by circling it with string attached to the branches, to aid the pickers in quickly and accurately locating these trees. To make the data accord with commercial practice, counts were taken at the time regular pickings were made. A few pickers were sent through the plats ahead of the main picking crew, with instructions to pick from the count trees all fruit ready for shipment, regardless of the presence of worms and rot. This fruit was placed in baskets and left under the respective trees. The writer then went from tree to tree and took, without discrimination, 10 fruits from the baskets. These were cut and records make as to the presence of worms, rot and scab. Two sets of records were taken for each variety. The data collected are presented in the following tables:

Variety: Belle

Date	Plat	Tree	Wormy	Brown Rot	Scab	Worms & Rot	Worms & Scab	Sound	Total
6/28	1	1	3	.	.	.	.	7	10
6/28	1	2	5	.	.	.	.	5	10
6/28	1	3	1	.	1	.	.	8	10
6/28	1	4	3	.	.	.	.	7	10
6/28	1	5	2	.	.	.	.	8	10
6/28	1	6	2	1	.	.	.	7	10
6/28	1	7	2	.	.	.	.	8	10
6/28	1	8	.	.	.	.	.	10	10
6/28	1	9	4	.	.	.	.	6	10
6/28	1	10	5	.	.	.	.	5	10
TOTAL	.	.	27	1	1	.	.	71	100
7/1	1	1	6	.	.	.	.	4	10
7/1	1	2	1	1	.	1	.	7	10
7/1	1	3	4	1	.	.	.	5	10
7/1	1	4	2	2	.	.	.	6	10
7/1	1	5	3	1	.	.	.	6	10
7/1	1	6	4	1	.	.	.	5	10
7/1	1	7	5	1	.	.	.	4	10
7/1	1	8	3	.	.	.	.	7	10
7/1	1	9	6	.	.	.	.	4	10
7/1	1	10	4	.	.	.	.	6	10
TOTAL	.	.	38	7	.	1	.	54	100
6/28	2	1	5	1	.	.	.	4	10
6/28	2	2	5	.	.	.	.	5	10
6/28	2	3	6	.	.	.	.	4	10
6/28	2	4	4	.	.	.	.	6	10
6/28	2	5	4	.	1	.	.	5	10
6/28	2	6	6	.	.	.	.	4	10
6/28	2	7	6	.	.	.	.	4	10
6/28	2	8	5	.	.	.	.	5	10
6/28	2	9	3	.	.	.	.	7	10
6/28	2	10	3	.	.	.	.	7	10
TOTAL	.	.	47	1	1	.	.	51	100
7/1	2	1	4	2	1	.	1	2	10
7/1	2	2	2	.	.	.	.	8	10
7/1	2	3	6	.	.	.	2	2	10
7/1	2	4	4	.	.	2	.	4	10
7/1	2	5	2	1	1	.	.	6	10
7/1	2	6	5	3	.	1	.	1	10
7/1	2	7	2	.	.	.	2	6	10
7/1	2	8	4	.	3	.	.	3	10
7/1	2	9	1	1	.	.	.	8	10
7/1	2	10	4	2	.	1	.	3	10
TOTAL	.	..	34	9	5	4	5	43	100

Variety: Belle.

Date	Plat	Tree	Wormy	Brown Rot	Scab	Worms & Rot	Worms & Scab	Sound	Total
6/28	3	1	6	1	.	2	1	0	10
6/28	3	2	5	1	1	.	1	2	10
6/28	3	3	3	1	1	.	3	2	10
6/28	3	4	.	.	2	4	4	0	10
6/28	3	5	3	1	.	.	4	2	10
6/28	3	6	6	1	.	1	1	1	10
6/28	3	7	1	.	2	.	7	0	10
6/28	3	8	.	.	2	1	6	1	10
6/28	3	9	.	9	1	.	.	0	10
6/28	3	10	.	1	1	.	8	0	10
TOTAL	.	.	24	15	10	8	35	8	100
7/1	3	1	1	1	1	4	2	1	10
7/1	3	2	5	.	3	.	1	1	10
7/1	3	3	2	1	.	1	5	1	10
7/1	3	4	.	.	2	6	2	0	10
7/1	3	5	2	.	1	1	6	0	10
7/1	3	6	1	1	1	1	6	0	10
7/1	3	7	4	1	1	1	3	0	10
7/1	3	8	.	1	6	1	1	1	10
7/1	3	9	.	9	.	.	1	0	10
7/1	3	10	1	1	1	1	6	0	10
TOTAL	.	.	16	15	16	16	33	4	100
6/28	4	1	3	1	.	.	.	6	10
6/28	4	2	3	1	.	.	.	6	10
6/28	4	3	7	.	.	.	.	3	10
6/28	4	4	5	.	.	.	.	5	10
6/28	4	5	6	.	.	.	.	4	10
6/28	4	6	2	.	.	.	.	8	10
6/28	4	7	6	.	.	.	.	4	10
6/28	4	8	5	.	.	.	.	5	10
6/28	4	9	6	.	.	.	.	4	10
6/28	4	10	5	.	.	.	.	5	10
TOTAL	.	.	48	2	.	.	.	50	100
7/1	4	1	4	1	.	2	.	3	10
7/1	4	2	2	.	.	1	.	7	10
7/1	4	3	2	.	.	1	.	7	10
7/1	4	4	7	.	.	.	.	3	10
7/1	4	5	8	.	.	.	.	2	10
7/1	4	6	5	.	.	.	.	5	10
7/1	4	7	8	.	.	.	.	2	10
7/1	4	8	4	.	.	1	.	5	10
7/1	4	9	5	1	.	.	.	4	10
7/1	4	10	6	.	.	.	.	4	10
TOTAL	.	.	51	2	.	5	.	42	100

Variety: Belle.

Date	Plat	Tree	Wormy	Brown Rot	Scab	Worms & Rot	Worms & Scab	Sound	Total
6/28	5	1	4	.	.	.	.	6	10
6/28	5	2	1	.	.	.	.	9	10
6/28	5	3	3	.	.	.	.	7	10
6/28	5	4	4	.	.	.	.	6	10
6/28	5	5	7	.	.	.	.	3	10
6/28	5	6	2	.	.	.	.	8	10
6/28	5	7	3	.	.	.	.	7	10
6/28	5	8	3	.	.	.	.	7	10
6/28	5	9	5	.	.	.	.	5	10
6/28	5	10	2	.	.	.	.	8	10
TOTAL	.	.	34	.	.	.	.	66	100
7/1	5	1	2	1	.	2	.	5	10
7/1	5	2	5	.	.	.	.	5	10
7/1	5	3	4	1	.	.	.	5	10
7/1	5	4	3	.	.	1	.	6	10
7/1	5	5	1	.	.	.	.	9	10
7/1	5	6	4	1	.	1	.	4	10
7/1	5	7	5	.	.	.	.	5	10
7/1	5	8	3	1	.	1	.	5	10
7/1	5	9	2	2	.	.	.	6	10
7/1	5	10	5	.	.	.	.	5	10
TOTAL	.	..	34	6	.	5	.	55	100

Average per cent.

Variety: Belle.

Material Used	Wormy	Brown Rot	Scab	Worms & Rot	Worms & Scab	Sound	Total
Plat							
1 Atomic Sulphur....	32.5	4.	0.5	0.5	0	62.5	100
2 80-10-10 Dust.....	40.5	5.	3.0	2.0	2.5	47.0	100
3 Check	20.0	15.	13.0	12.0	34.0	6.0	100
4 Self-boiled Lime-Sulphur.....	49.5	2.0	....	2.5	....	46.0	100
5 Atomic sulphur & 80-10-10 Dust.....	34.0	3.0	....	2.5	....	60.5	100

Variety: Elberta.

Date	Plat	Tree	Wormy	Brown Rot	Scab	Worms & Rot	Worms & Scab	Sound	Total
7/7	1	1	1	.	.	.	.	9	10
7/7	1	2	2	.	.	1	.	7	10
7/7	1	3	3	1	.	.	.	6	10
7/7	1	4	.	.	.	.	.	10	10
7/7	1	5	1	1	.	.	.	8	10
7/7	1	6	1	.	.	.	.	9	10
7/7	1	7	3	.	.	1	.	6	10
7/7	1	8	1	.	.	.	.	9	10
7/7	1	9	1	1	.	.	.	8	10
7/7	1	10	3	3	.	.	.	4	10
TOTAL	.	..	16	6	.	2	.	76	100
7/11	1	1	4	1	.	1	.	4	10
7/11	1	2	4	1	.	.	.	5	10
7/11	1	3	2	2	.	.	.	6	10
7/11	1	4	3	1	.	.	.	6	10
7/11	1	5	1	.	.	1	.	8	10
7/11	1	6	2	1	.	1	.	6	10
7/11	1	7	2	1	.	.	.	7	10
7/11	1	8	3	.	.	.	.	7	10
7/11	1	9	3	.	.	1	.	6	10
7/11	1	10	1	1	.	1	.	7	10
TOTAL	.	..	25	8	.	5	.	62	100
7/7	2	1	1	.	.	.	.	9	10
7/7	2	2	2	.	.	.	.	8	10
7/7	2	3	1	1	.	.	.	8	10
7/7	2	4	4	.	.	.	.	6	10
7/7	2	5	2	.	.	.	.	8	10
7/7	2	6	5	1	.	.	.	4	10
7/7	2	7	3	1	.	.	.	6	10
7/7	2	8	1	.	.	.	.	9	10
7/7	2	9	4	.	.	.	.	6	10
7/7	2	10	3	.	.	1	.	6	10
TOTAL	.	..	26	3	.	1	.	70	100
7/11	2	1	1	2	.	.	.	7	10
7/11	2	2	.	.	.	1	.	9	10
7/11	2	3	1	.	.	.	.	9	10
7/11	2	4	1	.	.	1	.	8	10
7/11	2	5	3	.	.	.	.	7	10
7/11	2	6	5	1	.	2	.	2	10
7/11	2	7	3	.	.	.	.	7	10
7/11	2	8	2	.	.	.	.	8	10
7/11	2	9	1	.	.	.	.	9	10
7/11	2	10	.	.	.	.	.	10	10
TOTAL	.	..	17	3	.	4	.	76	100

Variety: Elberta.

Date	Plat	Tree	Wormy	Brown Rot	Scab	Worms & Rot	Worms & Scab	Sound	Total
7/7	3	1	5	.	.	.	.	5	10
7/7	3	2	3	1	.	1	.	5	10
7/7	3	3	3	3	.	1	.	3	10
7/7	3	4	3	1	.	.	.	6	10
7/7	3	5	1	1	1	5	.	2	10
7/7	3	6	2	4	.	4	.	.	10
7/7	3	7	4	.	.	6	.	.	10
7/7	3	8	2	.	.	4	.	4	10
7/7	3	9	3	.	.	2	.	5	10
7/7	3	10	4	2	.	2	.	2	10
TOTAL	.	..	30	12	1	25	.	32	100
7/11	3	1	1	1	1	1	.	6	10
7/11	3	2	2	2	.	1	.	5	10
7/11	3	3	5	.	.	.	.	5	10
7/11	3	4	2	3	.	1	.	4	10
7/11	3	5	2	.	.	3	.	5	10
7/11	3	6	1	3	.	3	.	3	10
7/11	3	7	1	3	.	3	1	2	10
7/11	3	8	.	8	.	.	.	2	10
7/11	3	9	1	6	.	2	.	1	10
7/11	3	10	.	5	.	4	.	1	10
TOTAL	.	..	15	31	1	18	1	34	100
7/7	4	1	2	.	.	.	.	8	10
7/7	4	2	4	.	.	.	.	6	10
7/7	4	3	4	.	.	.	.	6	10
7/7	4	4	2	.	.	.	.	8	10
7/7	4	5	5	.	.	.	.	5	10
7/7	4	6	3	4	.	.	.	3	10
7/7	4	7	2	.	.	.	.	8	10
7/7	4	8	2	1	.	.	.	7	10
7/7	4	9	4	1	.	.	.	5	10
7/7	4	10	4	1	.	.	.	5	10
TOTAL	.	..	32	7	.	.	.	61	100
7/11	4	1	4	2	.	.	.	4	10
7/11	4	2	3	1	.	.	.	6	10
7/11	4	3	2	.	.	.	.	8	10
7/11	4	4	2	1	.	.	.	7	10
7/11	4	5	.	2	.	.	.	8	10
7/11	4	6	1	2	.	.	.	7	10
7/11	4	7	.	3	.	.	.	7	10
7/11	4	8	.	1	.	.	.	9	10
7/11	4	9	3	5	.	.	.	2	10
7/11	4	10	4	2	.	.	.	4	10
TOTAL	.	..	19	19	.	.	.	62	100

Variety: Elberta.

Date	Plat	Tree	Wormy	Brown Rot	Scab	Worms & Rot	Worms & Scab	Sound	Total
7/7	5	1	.	.	.	.	.	10	10
7/7	5	2	.	2	.	.	.	8	10
7/7	5	3	7	.	.	1	.	2	10
7/7	5	4	6	.	.	.	.	4	10
7/7	5	5	5	.	.	.	.	5	10
7/7	5	6	3	.	.	.	.	7	10
7/7	5	7	2	1	.	2	.	5	10
7/7	5	8	1	.	.	1	.	8	10
7/7	5	9	1	1	.	2	.	6	10
7/7	5	10	6	1	.	.	.	3	10
TOTAL	.	..	31	5	.	6	.	58	100
7/11	5	1	.	.	.	.	.	10	10
7/11	5	2	.	2	.	1	.	7	10
7/11	5	3	3	1	.	.	.	6	10
7/11	5	4	4	4	.	.	.	2	10
7/11	5	5	1	7	.	.	.	2	10
7/11	5	6	1	4	.	.	.	5	10
7/11	5	7	1	2	.	.	.	7	10
7/11	5	8	2	1	.	.	.	7	10
7/11	5	9	2	6	.	.	.	2	10
7/11	5	10	4	.	.	.	.	6	10
TOTAL	.	..	18	27	.	1	.	54	100

Average Per Cent

Variety: Elberta.

Material Used	Wormy	Brown Rot	Scab	Worms & Rot	Worms & Scab	Sound	Total
Plat							
1 Atomic-sulphur	20.5	7.0	0.0	3.5	0.0	69.0	100
2 80-10-10 Dust.....	21.0	3.0	0.0	2.5	0.0	73.5	100
3 Check	22.5	21.5	1.0	21.5	.5	33.0	100
4 Self-Boiled Lime-sulphur	25.5	13.0	0.0	0.0	0.0	61.5	100
5 Atomic sulphur & 80-10-10 Dust	24.5	16.0	0.0	3.5	0.0	56.0	100

TABLES GIVING THE TOTAL PER CENT OF WORMS, BROWN ROT, AND SCAB FROM EACH PLAT

Variety: Georgia Belle:

Plat	Material Used	Wormy	Brown Rot	Scab
1	Atomic sulphur	33.0	4.5	0.5
2	80-10-10 Dust	45.0	7.0	5.5
3	Check	66.0	27.0	47.0
4	Self-boiled Lime-Sulphur	52.0	4.5	0.0
5	Atomic sulphur and 80-10-10 Dust	36.5	5.5	0.0

Variety: Elberta.

Plat	Material Used	Wormy	Brown Rot	Scab
1	Atomic Sulphur	24.0	10.5	0.0
2	80-10-10 Dust	23.5	5.5	0.0
3	Check	44.5	43.0	1.5
4	Self-boiled Lime-Sulphur	25.5	13.0	0.0
5	Atomic Sulphur and 80-10-10 Dust	28.0	19.5	0.0

DISCUSSION

These data on one season's tests show the value of sprayed versus unsprayed trees in the total production of sound fruit, but they are not conclusive as to the relative value of the sprays and dust used.

In the block of Georgia Belles, Plat 1, Atomic sulphur and arsenate of lead gave the best control of curculio, and the same results as self-boiled lime-sulphur in the control of brown rot. Plat 5, using two applications of Atomic sulphur and arsenate of lead, and one application of 80-10-10 dust was second in the control of both curculio and brown rot. In plat 2, three applications of 8-10-10 dust gave better control of curculio than did three applications of self-boiled lime-sulphur and arsenate of lead but the latter gave better control of brown rot. Plat 3, receiving no spray, had 14 per cent more curculio, 20 per cent more brown rot, and 41.5 per cent more scab than the plats where the poorest control of these were obtained by spray or dust.

In the Elberta block, plat 2, four applications of 80-10-10 dust gave the best control of both curculio and brown rot. In plats 1 and 4 Atomic sulphur, and self-boiled lime-sulphur respectively, gave almost as good control of curculio, but not as satisfactory control of brown rot. In plat 5, two applications of Atomic sulphur and two of 80-10-10 dust gave the poorest control of both curculio and brown rot of any of the treated plats. Plat 3, receiving no spray or dust, had 16.5 per cent more curculio, 23.5 per cent more brown rot, and 1.5 per cent more scab than the plats where the poorest control was obtained by the use of spray or dust.

The Georgia Belle, a white skinned variety, is apparently less resistant to the scab fungus than the Elberta, as indicatel by the much larger percentage of scab in the check plat of Georgia Belles than in the check plat of the Elbertas.

The larger percentage of brown rot in all but one of the Elberta plats was not due to this variety being less resistant than the Georgia Belle, but to the heavy rains at harvest time. Following a long period of dry weather the excess of water taken up by the trees at this time caused the Elberta fruits to crack. On 25 per cent of the fruit this cracking left unprotected areas. With the abundance of fresh conidia already produced on brown rot infections following curculio injuries, it was to be expected that a large per cent of the cracked fruit would become infected. The majority of Georgia Belles had been harvested before the heavy rains, and thus escaped the cracking.

In isolated orchards there was considerable cracking of Elberta fruits due to wet weather at harvest time, yet the fruit showed practically no brown rot because the fungus had not become established.

A small percentage of fruits in a number of orchards visited showed rotting, due to *Rhizopus sp.* This was evidently due to the wet weather at harvest time.

COST OF LABOR AND SPRAY MATERIALS

During 1921 opportunity was afforded to determine the relative cost of spraying versus dusting.

With the present prices of labor in Georgia a power sprayer, requiring three negroes, and two mules, may be operated for $3.50 per day, and a power duster, using two negroes and two mules, for $2.50 per day. The duster will cover from two to three times as many trees per day as a 200 gallon sprayer.

The data collected indicated that for 10 year old trees the cost per application of, self-boiled lime-sulphur was 1.57 cents per tree, Atomic sulphur 1.9 cents per tree, and 80-10-10 dust 2.1 cents per tree for the material used. A duster may be filled much more rapidly than a 200 gallon sprayer, therefore, if the time required for refilling is taken into consideration the total cost of applying dust would be very little higher than that of the liquid sprays.

DUST INJURY TO FRUIT

For several years past many of the commercial peach growers in the Piedmont section of Georgia have depended upon dust for the control of peach insects and diseases. During the seasons of 1920 and 1921 fruit in orchards using dust, showed considerable russeting and cracking of the skin. As the season advanced the russeting became more serious and at harvest time most of the fruits thus injured had to be discarded as culls. Growers have been inclined to attribute this russeting to abrasion of the skin from rubbing against twigs, etc., but observations would indicate that this is dust injury similar to that described and pictured by Fromme, Ralston and Elbert[8], as occurring on dusted peaches in Virginia, in 1920.

Associated with dust injury, but at times found separate from it, is a pitting of the skin of the fruit similar to that figured by Rolfs[9]. Growers have assumed that this pitting was due to dust injury, but specimens submitted to Mr. Lee M. Hutchins and Dr. John W. Roberts, of the Office of Fruit Disease Investigations, U. S. Department of Agriculture, were pronounced as infections due to *Bacterium Pruni E. F. Smith.* According to Rolfs[9], the pruning out of bacterial cankers on the limbs and the stimulation of the trees by an application of 600 to 900 pounds per acre of a complete fertilizer, to trees which have been well cultivated will aid in keeping this bacterial disease under control.

In some of the commercial orchards north of the Fort Valley section the Hale variety is planted quite extensively and appears to approach nearer perfection in these Piedmont soils. The dust injury and bacterial infection above mentioned, are more serious on the Hale than on other varieties raised in the same section. In one case observed in 1921 blocks of trees of the Hiley and Hale varieties adjoined. In dusting the machine went from one variety to the other without varying the amount of dust applied to each tree. At the time the Hileys were ready to harvest less than five per cent of the fruit showed dust injury; while adjoining trees of the

Hale variety showed as high as 35 per cent of injury. This injury on the Hale fruits became more pronounced as the season of maturity approached. This indicates that the skin of the Hale peach is more tender or more subject to dust injury than the other commercial varieties used in Georgia.

The dust injury combined with the failure of dust to control curculio in 1921 has caused some large commercial growers to consider returning to the use of liquid sprays in 1922. Other equally successful growers intend to test further the value of dust before discarding it.

MALNUTRITION

On April seventh, while the second application of spray was being applied to the test plats, a mottling and dwarfing of the leaves of several varieties of peaches was observed. In some cases this mottling was confined to the terminal growth of a few twigs. In other cases practically all of the leaves were less than normal size and were distinctly yellowish in color, in marked contrast to the normal leaves. It was at first thought that this mottling was due to frosts and cold winds, but examination of the fruit showed no signs of frost injury. In other orchards, examined later, where the fruit was so badly injured by frost as to cause shriveling and blackening in the region of the pit, no signs of leaf injury similar to the above appeared.

The 10 year old trees which bore the mottled leaves were on land which had received no potash for five years, except what was present in the cotton seed meal, raw bone meal, and tankage, used with acid phosphate to make up a so-called 9-3-0 mixture. This had been used at the rate of one ton per acre, and was applied broadcast.

The mottled leaves were brittle and on being bent or twisted, cracked easily as do leaves of Irish potatoes and cotton which are suffering from so-called potash starvation. Normal appearing peach leaves from the same orchard were leathery and did not crack on being bent until surfaces met. Further study of this trouble is now under way.

LOSSES DUE TO CLOSE PLANTING

In the southern states the long growing season favors the rapid growth of peach trees. Under favorable conditions peach trees are longer-lived in the South, there being less killing of trees from cold winters. By the time trees come into bearing at two to three years of age they have reached considerable size, often having 10 feet spread of branches. Knowing that the trees will increase in size during the 10 or 15 years of profitable culture after coming into bearing, it is important that they be set far enough apart to allow for this increase in growth.

In many of the older commercial orchards of Georgia the trees were set from 16 to 18 feet apart. Before such trees are 10 years of age their spread of branches leaves very little space between the trees. In driving a power sprayer or a tractor up and down such rows, branches are broken and wounded. As the fruit approaches maturity the branches are bent

outward and downward so that in many cases those of adjoining trees intermingle. Wagons with wide basket racks break branches and knock off many fruits as they pass through the orchard at harvest time.

The successful operation of commercial orchards necessitates the use of modern machinery and to allow space for the operation of such machinery as power sprayers, dusters, tractors, etc., peach trees should be set at least 20 feet apart.

CALCIUM ARSENATE INJURY TO YOUNG TREES

In some commercial peach orchards it is the practice to plant the land between the trees to cotton for several years while the trees are young. With the advent of the boll weevil (*Anthonomus grandis, Boh.*) some growers have begun using calcium arsenate dust to keep this pest in check on their cotton. To be effective in boll weevil control the dust has to be applied a number of times during the season. In dusting the cotton some of the calcium arsenate falls upon the peach trees, where its frequent application causes burning and defoliation of the trees. This may result in serious injury to young peach trees as seen in figure 6. In this case some of the one year old trees were killed and others so badly defoliated that they were injured permanently. Trees in the same orchard which were not inter-planted with cotton, and thus received no applications of calcium arsenate were all healthy and in full leaf.

THE RELATION OF SHARE CROPPING TO INSECT AND DISEASE CONTROL

In the commercial peach sections of Georgia, with many large orchards in close proximity, the control of peach insects and diseases is a community proposition. One grower can do but little in the way of control if his neighbors fail to co-operate in cleaning up their orchards.

In some cases the owners of commercial orchards personally supervise the orchard operations. In other cases the orchard lands are operated on a share crop basis. In such cases the terms of the contract or lease should be so arranged that the tenant will have an incentive to make improvements and thus retain a standard equal to that of well-cared-for-orchards. As a rule, under the present system of cotton or general farming, the tenant has a short term lease, generally for one year. With such a lease the tenant is not inclined to make improvements on the land, except those from which he may anticipate some return within the duration of his lease. The tenant who makes improvements, such as increasing soil fertility, thereby increases the competition for that land, and under the short term lease he would have no assurance of receiving any benefits from such improvements, unless he met the higher terms of rental which would result from competition of prospective tenants who desire to lease the improved land.

In the commercial peach orchard there is no profitable return on the investment until the trees come into bearing during the third or fourth year. The income from an orchard should increase during the 10 years

FIGURE 6

The young peach trees adjoining rows of interplanted cotton are almost defoliated from calcium arsenate used in dusting the cotton for boll weevil control. The rows of trees which received no calcium arsenate are in full leaf and considerably larger in size.

after coming into bearing provided it is given suitable care. A lease now in operation in connection with a profitable commercial orchard in this State is made for a period of 10 years. Under the terms of this lease the owner furnishes the land to offset the labor of the tenant. All expenses such as trees, fertilizer, extra labor, spray materials, packing sheds, shipping materials, transportation charges, etc., are divided equally and all profits are shared equally. At the expiration of the 10 year period if it is not agreeable to renew the lease, the land with all the improvements reverts to the owner. The terms of a lease might be varied somewhat with equally good results. The fact that the above has proven successful to the extent that the tenant has improved the orchard, both land and trees, from year to year with profit to both himself and the owner should commend such a lease to those contemplating the operation of a commercial orchard on a tenant basis.

CONCLUSION

The growers who have thought seriously about the results obtained in the control of insects and diseases in 1920 and 1921 with sprays and dust have come to the conclusion that these pests cannot be held in check in commercial orchards by the use of spray and dust alone. Growers who cleaned up their orchard in 1920 agree that such clean culture was worth more in the control of insects and diseases on their 1921 crop than was the spray or dust used during the growing season. In other words spraying or dusting is necessary, but should be supplementary to clean culture.

From the data collected in a number of commercial orchards in various sections of this State during the past two years and from the spray tests conducted in a commercial orchard in 1921 it is concluded that the cleaning up of orchards as a community proposition following harvest, in order to destroy peach insects and diseases over large areas, is the only sure means of holding these pests in check. If the orchards are thoroughly cleaned, then three or possibly four applications of spray or dust may be expected to protect the fruit from the few insects which remain. And with curculio under control brown rot will no longer prove a menace to the peach industry of Georgia.

SUMMARY

Losses due to curculio and brown rot indicate that peaches cannot be protected from these pests by the use of sprays or dusts alone in the commercial orchards of Georgia.

The control of brown rot is dependent upon the control of curculio because 90 percent of the brown rot infections occur at curculio injuries.

In orchards which were some distance from the large peach sections, curculio and brown rot caused much less injury to the fruit.

Mummied fruits left on the trees and twig cankers are important sources from which conidia of the brown rot fungus are disseminated in the spring.

Blossom blight is the first indication of activity of the brown rot fungus in the spring.

Late maturing varieties were less subject to blossom infection than early varieties in 1921.

Blighted blossoms remain attached to the trees throughout the season and are centers from which condia spread to the fruits as they approach maturity.

The growth of the causal fungus from the blighted blossoms into the twigs is one of the chief sources of cankers which over-winter the fungus.

The data collected during the past two years indicate that peach orchards must be thoroughly cleaned after the harvesting of the fruit.

With the orchards free from hibernating and breeding places for curculio and brown rot, three or possibly four applications of spray or dust during the growing season should protect the fruit from these pests.

Tests conducted in a commercial orchard proved the value of sprays and dust, but are not conclusive as to which combination is the best for use on the varieties of peaches included in these tests.

Observations indicate that the Georgia Belle is more susceptible to scab than the Elberta.

Cracking of the fruit due to heavy rains greatly reduces the effectiveness of sprays and dust in the control of brown rot.

When the cost of both labor and material are taken into consideration there is not much difference between the cost of liquid sprays and dust.

Dust injury to fruit is a factor to be considered in selecting materials for insect and disease control.

Close planting of peach trees hinders orchard operations and causes considerable loss of fruit.

Calcium arsenate injury of young peach trees may occur when interplanted cotton is dusted for boll weevil control.

In operating a peach orchard on a share crop basis the lease should be of sufficient duration to encourage the tenant to properly care for the orchard.

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